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THE MAGNAVOX COMPANY

URBANA, ILLINOIS

MONTHLY PROGRESS REPORT NO. 15
(From 1 March to 31 March 1963)

5 April 1963

SOLID-STATE ARM SAFE DEVICE (PHASE III)
CONTRACT DA-11-022-ORD-4048

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PROJECT DEFINITION

The purpose of this third phase four month program is to design, develop and fabricate at least three miniature electronic Solid State Arm Safe Devices capable of functioning in various warheads for Army missiles under a wide range of environmental conditions. The first outputs must activate a squib at a preselected acceleration. The second output is to have a Solid State switching circuit which will provide an electrical change of state after the missile has traveled a preselected distance from the launch site.

SCOPE

The three (3) miniature Solid State Arm Safe Devices will have the following properties:

- 1) Maximum acceleration - up to 40 g's.
- 2) Total time before arming - up to 100 seconds
- 3) Total distance in flight before arming - up to 100,000 meters.
- 4) Vibration 21 to 700 cps at ± 10 g's for ten (10) minutes in each of three (3) orthogonal axis.
- 5) Maximum temperature range -65°F to $+200^{\circ}\text{F}$.
- 6) 95% humidity for six (6) hours at 160°F .
- 7) The volume of the miniature units shall not exceed two (2) cubic inches; and the weight shall not exceed six (6) ounces.
- 8) The size of the units shall be cylindrically shaped (1.5 inches in diameter and approximately one inch high).
- 9) The solid state circuits shall not require more than 6 volts (5.6 volts) with a current drain of no more than 200 milliamperes
- 10) The miniature models must withstand a 400 g drop for a period of one (1) millisecond regardless of impact orientation.

- 11) The miniature Solid State Arm Safe Device shall have one (1) output switch which shall be activated as a function of a particular acceleration; the other output switch shall be activated as a function of distance. An attempt will be made to receive acceleration switchings with an accuracy to within $\pm 2\%$. The distance accuracy must be less than $\pm 25\%$.
- 12) The solid state devices shall be classified as demonstration units which shall have small connectors compatible with the miniaturization scheme.

Performance of the above program of work shall be under supervision of the Technical Supervisor (Picatinny Arsenal).

The above work shall be accomplished on or before May 7, 1963. An additional 30 days will be allowed for the preparation and submission of the Final Summary Report required to be furnished under the contract.

TECHNICAL DISCUSSION

The first unit has been fabricated and is undergoing the functional tests before delivery which will likely be the second week in April. The remaining two units will be ready for delivery the first week in May.

Lately there has been a breakthrough in the transducer portion of the Miniature Solid-State Arm Safe Device. This is based upon the possibility of utilizing a resistive paint placed between two plates in the form of a miniature pillbox to sense the acceleration and convert it to a proportional output voltage. These units will cost in the order of \$5.00 each in production quantities compared to a projected cost of semiconductor transducers of approximately \$35.00. This means that the cost of the entire Arm Safe Device would be approximately \$25.00 each instead of \$50.00 in production quantities of 1000 or more as previously estimated. A few more facts about the present concepts are depicted below.

The use of a pressure sensitive paint to build an accelerometer is attractive from several points of view. One is the potentially small size of such a device. It is estimated that such an accelerometer would be on the order of 1 in³. The properties of the paint are such as to permit a very high order of sensitivity. Realizable values of resistance permit the use of a spot of pressure sensitive paint 0.25" in diameter and 0.002" thick. There exists a resistance of effective infinity at no load to 30 ohms at 1 lb. The paint can be prestressed to achieve a desirable resistance at no load, e.g. 20 megohms. Expressing sensitivity as the ratio of change of force to change in resistance:

$$S = \Delta F / \Delta R = 1 \text{ lb} / 20 \times 10^6 = 0.05 \times 10^{-6} \text{ lb/ohm} = 22 \times 10^{-4} \text{ dynes/ohm.}$$

Assuming a 1 gram inertial mass, a change occurs in acceleration of $22 \times 10^{-4} \text{ cm/sec}^2$ or approximately $7 \times 10^{-5} \text{ ft/sec}^2$. This assumes of course, that the paint is linear over the entire range of force. This device would then be able to sense a maximum of 45 g's.

A great deal of work needs to be done to determine exactly what variables determine the resistance of the paint in addition to force, e.g. temperature, method of construction, etc. This is very important in order to develop a method of fabrication which will give reproducible results from transducer to transducer. It is expected that a great deal of process control will be necessary.

Initially it is planned that these transducers will be used with operational amplifiers to detect the change in resistance of the paint. It is felt that in this way, maximum use of experience gained in the fabrication of the previous miniature S & A devices will be made. However, the paint transducer will lend itself to A. C. circuitry much easier than other strain gauges. Considerable improvement in stability can therefore be achieved.

Because of the extremely low cost of these devices, reliability can be improved through redundant circuitry in a series-parallel arrangement.

At least one of these new resistive paint-pressure sensitive transducers will be fabricated, tested and designed into a deliverable miniature Solid State Arm Safe Device during the present phase of the program.

WORK TO BE ACCOMPLISHED

The remaining two units will be fabricated and tested during the month of April and will be ready for delivery by 7 May 1963. One of these units will utilize the special pressure sensitive paint type transducer.

HOURS EXPENDED DURING REPORT PERIOD

Engineering	16.0 hours
Technician	176.4 hours
Services	<u>32.2</u> hours

TOTAL	224.6 hours
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